Modelling Nitrogen Deposition in Germany from 2000-2015

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Abstract

Biodiversity of terrestrial ecosystems in Germany is strongly affected by atmospheric deposition of nitrogen. To support legislative needs to protect ecosystems from nitrogen deposition within a project of the German Environment Agency, total nitrogen deposition was modelled over a period of 16 years. Resulting deposition data is available on a 1x1 km² grid for the whole area of Germany, for oxidized, reduced and total inorganic nitrogen compounds, for 10 different landuse categories and for dry, wet, occult and total deposition fluxes. On average, deposition in Germany has decreased from above 649 Gg(N)/yr in 2000 to 529 Gg(N)/yr in 2015

Keywords: nitrogen, deposition, modelling

1. Introduction

Eutrophication is one of the main reasons threatening biodiversity in Germany. To quantify the risk for biodiversity caused through nitrogen deposition, critical loads and their exceedance are calculated and mapped (CLRTAP, 2017). In Germany national data on the exceedance of critical loads for eutrophication are used as indicators for the National Strategy on Biodiversity and for the National Sustainability Development Strategy. In addition, to prevent ecosystems from unwanted further excessive nitrogen deposition, according to the German emission control and nature protection legislation, nitrogen deposition has to be assessed, when new nitrogen emitting projects are submitted. Due to these legal requirements there is the need for high-resolution and longtime nitrogen deposition data in Germany. Within the current work, national high resolution maps on atmospheric nitrogen deposition in Germany were calculated for the first time for a long time series from 2000 to 2015.

2. Method

The atmospheric dispersion modelling was done with chemistry transport model LOTOS-EUROS (TNO, 2017). The European domain of the model has a resolution of 0.5°longitude by 0.25° latitude. Simulations over Germany using a nesting approach were calculated with a resolution of 0.125° longitude by 0.0625°latitude. Changes in concentration and deposition were calculated on an hourly basis for each grid cell for the years 2000-2015. The calculation of the dry deposition was parametrized for 10 aggregated landuse classes based on Corine Land Cover data. The resulting flux in each grid cell was calculated from the landuse specific deposition estimates and the corresponding share of each landuse class. Landuse independent wet deposition maps were produced on a resolution of 1x1 km^2. Measured concentrations in rain were interpolated using a geostatistical kriging approach and combined via residual kriging with spatial distribution of concentration in rain from the chemistry transport model. The resulting data was combined with precipitation maps of the German National

Meteorological Service (DWD) to produce a deposition field covering the entire surface of Germany. Occult deposition for forest landuse classes were calculated from cloud water concentration of nitrogen and cloud water deposition rates from the DWD. Cloud concentration data were derived from the concentration in rainwater using empirical factors. After interpolation of the results of dry and occult deposition onto the finely resolved 1x1 km² grid, total deposition fluxes with a spatial resolution of 1x1 km² were calculated by addition of the wet, dry and occult deposition fluxes.

3. Results

Nitrogen deposition in Germany has decreased from above 649 Gg N a-1 in 2000 to 529 Gg N a-1 during 2015 (Figure 1). The largest contribution to this negative trend is made by a decrease in oxidized nitrogen deposition of more than 100 Gg N a-1, whereas reduced nitrogen deposition has only decreased by about 15 Gg N a-1. The total NOy deposition roughly consists of 60 % wet deposition and 40 % dry deposition. Dry deposition is more important in the deposition of reduced nitrogen (47 %). Occult depositions accounts for not more than 2 %.

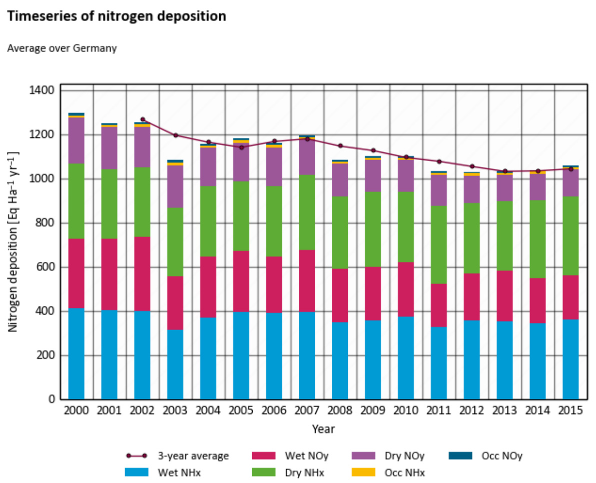

Figure 1: Total Nitrogen deposition over Germany (2000-2015)

Acknowledgements

Special thanks for funding this work go to the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and the German Environment Agency. In addition we would like to thank those measuring networks in the different German federal states that delivered us measured data of nitrogen concentration in rain water and to the Thünen-Institute of Forest Ecosystems to provide us canopy budget data of the level-II Forest monitoring plots

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